

1 TITLE OF THE INVENTION

2 FUEL CELL POWER GENERATION REFRIGERATING SYSTEM

3 BACKGROUND OF THE INVENTION4 Technical Field of the Invention

5 [0001] This invention relates to a fuel cell power generation refrigerating system intended  
6 to use output power from a fuel cell as operating power of a vapor-compression  
7 refrigerating machine and to use power from a commercial system according to necessity.

8 Description of the Background Art

9 [0002] Driving an inverter-drive air-conditioning outdoor unit by output power of a fuel  
10 cell (cf. Japanese Patent Application Laid-Open No. 8-5190 (1996)) ~~patent document 1~~  
11 and providing a battery or a fuel cell for supplementally supplying power to an inverter-  
12 drive air-conditioning outdoor unit driven by power from a commercial system (cf.  
13 Japanese Patent Application Laid Open No. 2001-201138) ~~patent document 2~~) have  
14 conventionally been proposed.

15 ~~Patent document 1: Japanese Patent Application Laid Open No. 2001-201138. 8-5190~~

16 ~~Patent document 2: Japanese Patent Application Laid Open No. 2001-201138~~

17 Disclosure of Invention18 Problems to be solved by Invention

19 [0003] The description of JP8-5190 ~~the patent document 1~~ is only directed to driving an  
20 inverter-drive air-conditioning outdoor unit by generated power of a fuel cell, and  
21 therefore, it is not possible to make effective use of the fuel cell when an air conditioner is  
22 stopping.

23 [0004] JP2001-201138 ~~The patent document 2~~ has an object to save power at the time of  
24 air-conditioning peak load and thus only describes a supplemental use of a fuel cell in case  
25 of request for power savings. Further, it does not at all mention the effective use

1 throughout the year such as the time when air conditioning is stopping and an intermediate  
2 period, etc. Therefore, it is not possible to make effective use of the fuel cell.

3 [0005] A decentralized generator has conventionally been proposed, which has a  
4 generating set provided separately from an air conditioner. Therefore, a power system  
5 needs to be provided with a power board for connection with a generator and a power  
6 board for air conditioning separately, which increases the footprint and construction costs.

7 **SUMMARY OF THE INVENTION**

8 [0006] This invention has been made in view of the above-described problems, and has an  
9 object to provide a fuel cell power generation refrigerating system capable of making  
10 effective use of a fuel cell as well as preventing or suppressing increase in footprint and  
11 construction costs.

12 **Means for solving the Problems**

13 [0007] A fuel cell power generation refrigerating system of the present invention provides  
14 driving power of a compression-machine-driving motor of a vapor-compression  
15 refrigerating machine by power generated by a fuel cell, and supplies power generated by  
16 the fuel cell to a commercial system side in response to that total required power of the  
17 vapor-compression refrigerating machine is below a power generation capacity of the fuel  
18 cell and that the vapor-compression refrigerating machine is stopping.

19 [0008] A refrigerating machine mentioned here is a refrigerating machine in a broad  
20 sense, including all electric-driven ones that adopt a compression cycle, such as a heat  
21 pump air conditioner.

22 [0009] According to this invention, it is possible to make effective use of generated power  
23 of the fuel cell throughout the year and to allow combined use of a power board for a  
24 generating set and a power board for air conditioning, so that an economically-improved  
25 energy-efficient fuel cell power generation refrigerating system can be constructed with

1 reduced footprint and equipment/construction costs.

2 [0010] Further, in a building already equipped with an electric air conditioner, introducing  
3 the present system when renewing the electric air conditioner allows an already-provided  
4 power board for air conditioning to be used as-is as the power board for the generating set,  
5 which can significantly reduce introductory initial costs.

6 [0011] A fuel cell power generation refrigerating system of another invention comprises: a  
7 vapor-compression refrigerating machine; a power board supplying operating power to the  
8 vapor-compression refrigerating machine using a power supply of a commercial system as  
9 an input; a fuel cell; a first power conversion elementmeans-performing predetermined  
10 power conversion using an output of the fuel cell as an input to supply operating power to  
11 a compression-machine-driving motor of the vapor-compression refrigerating machine;  
12 and a power supply control elementmeans-providing driving power of a compression-  
13 machine-driving motor of the vapor-compression refrigerating machine by power  
14 generated by the fuel cell and supplying power generated by the fuel cell to the  
15 commercial system side in response to that total required power of the vapor-compression  
16 refrigerating machine is below a power generation capacity of the fuel cell and that the  
17 vapor-compression refrigerating machine is stopping.

18 [0012] A refrigerating machine mentioned here is a refrigerating machine in a broad  
19 sense, including all electric-driven ones that adopt a compression cycle, such as a heat  
20 pump air conditioner.

21 [0013] According to this invention, it is possible to make effective use of generated power  
22 of the fuel cell throughout the year and to allow combined use of the power board for the  
23 generating set and power board for air conditioning, so that an economically-improved  
24 energy-efficient fuel cell power generation refrigerating system can be constructed with  
25 reduced footprint and equipment/construction costs.

1 [0014] Further, in a building already equipped with an electric air conditioner, introducing  
2 the present system when renewing the electric air conditioner allows an already-provided  
3 power board for air conditioning to be used as-is as the power board for the generating set,  
4 which can significantly reduce introductory initial costs.

5 [0015] In these cases, in a refrigerating machine which drives a compression machine via  
6 an inverter, it is preferable that a second power conversion element be further  
providedmeans between the commercial system and the compression-machine-driving  
7 motor, motor and that the first power conversion elementmeans between the fuel cell and  
8 the compression-machine-driving motor and the second power conversion element share  
9 the same inverter, which achieves reduced footprint and equipment/construction costs as  
10 well as reduced conversion losses of the inverter, so that economy and energy efficiency  
11 can further be improved.

13 [0016] Further, it is preferable that~~preferably~~, a plurality of compression machines for  
14 vapor-compression refrigerating machine and a plurality of inverters be further provided,  
that theare provided. The number of compression machines beis controlled according to  
16 required operating load of the vapor-compression refrigerating machine, and that  
17 generated power of the fuel cell beis supplied to the commercial system side from an  
18 inverter in a not-operating compression machine system, which allows generated power of  
19 the fuel cell to be also supplied to the commercial system side at the time of partial load  
20 operation.

21 [0017] Further, it is preferable that a bidirectional AC/DC inverter be adopted as an  
22 AC/DC converter to be connected with the aforementioned commercial system, which  
23 allows power supply to the refrigerating machine side and power supply to the commercial  
24 system side to be separated, so that surplus generated power of the fuel cell can be  
25 supplied to the commercial system side without being affected by operating frequencies of

1 the refrigerating machine.

2 [0018] Further, it is preferable that~~preferably~~, a plurality of compression machines for the  
3 vapor-compression refrigerating machine be further provided, and that some~~are provided~~.  
4 Some of the motors for driving some of the compression machines be~~are~~ connected  
5 directly to the commercial system side, which can achieve reduced capacity of the inverter  
6 as well as reduced costs and apparatus volume.

7 [0019] Further, it is preferable that~~preferably~~, a capacity of a fuel cell be~~is~~ set higher than  
8 a capacity of an inverter supplying operating power to the compression-machine-driving  
9 motor of a vapor-compression refrigerating machine, and that generated power be~~is~~  
10 supplied to the commercial system side via the bidirectional AC/DC inverter in response  
11 to that the fuel cell is operating at the maximum capacity, so that power can also be  
12 supplied to the commercial system side at the time when the vapor-compression  
13 refrigerating machine is operating at the maximum capacity.

14 [0020] Further, it is preferable that~~preferably~~, the amount of power supply from the  
15 commercial system side to a system inside a building including a fuel cell power  
16 generation refrigerating system be~~is~~ detected, and that power output control of the fuel cell  
17 power generation refrigerating system be~~is~~ performed in response to the detected amount  
18 of power supply, allowing appropriate capacity control of the fuel cell, which can prevent  
19 reverse power flow to system power and the like.

20 [0021] Further, it is preferable that~~preferably~~, battery element~~means~~ connected in  
21 parallel to the fuel cell be~~is~~ further included. In the case where a general load makes fast  
22 load fluctuations so that the operating capacity of the fuel cell does not follow, the battery  
23 element~~means~~ is charged and discharged, which allows the imbalance between  
24 consumption power of the load and amount of power generation of the fuel cell to be  
25 counteracted.

1 [0022] Further, it is preferable that~~preferably~~, the amount of power supply from the  
2 commercial system side to a system inside a building including the fuel cell power  
3 generation refrigerating system be~~is~~ detected, that it be~~is~~ detected that the detected amount  
4 of power supply has been reduced to a degree that may cause reverse power flow, and that  
5 in response to this detection, an operating capacity of the vapor-compression refrigerating  
6 machine be~~is~~ increased forcedly until the fuel cell follows a load, so that the delay in  
7 following the load can be prevented without providing the battery element~~means~~, and in  
8 the case where the battery element~~means~~ is provided, the capacity of the battery  
9 element~~means~~ can be reduced.

10 [0023] Further, it is preferable that~~preferably~~, a plurality of fuel cell power generation  
11 refrigerating systems be~~are~~ provided for one power customer, which allows close follow-  
12 up to a refrigeration load as well as improved follow-up of power to the load by  
13 controlling the number of units even in the case where the general load is small, and  
14 further, the reliability of power supply can be increased.

15 [0024] Further, it is preferable that~~preferably~~, a plurality of fuel cell power generation  
16 refrigerating systems are provided for one power customer, and a controller be~~is~~ provided  
17 in common for the plurality of fuel cell power generation refrigerating systems, and that  
18 the~~systems~~. The controller provided in common at least control~~control~~s operation of fuel  
19 cells of the plurality of fuel cell power generation refrigerating systems, which allows a  
20 scheduled operation, total generation capacity control and the like to be carried out  
21 efficiently.

22 [0025] Further, it is preferable that~~preferably~~, the amount of power supply from the  
23 commercial system side to a system inside a building including the fuel cell power  
24 generation refrigerating system be~~is~~ detected, and that the controller provided in common  
25 control~~control~~s operation of the fuel cells in response to the detected amount of power

1 supply. Concentration of information to the controller allows appropriate concentrated  
2 operation control.

3 [0026] Further, it is preferable that ~~preferably~~, fee output elementmeans at least  
4 outputting an electricity fee and a fuel fee and a control elementmeans controlling  
5 operation of the fuel cell and performing distribution control of output power in response  
6 to the fees ~~beare~~ further provided, which can perform fine priority-giving output control  
7 (control as to which output is given priority) according to season, time, and the like, so  
8 that running merits can be maximized.

9 [0027] Further, it is preferable that ~~preferably~~, the aforementioned fee output element  
10 ~~allowmeans~~ ~~allows~~ unit cost data and fee calculation software for fee calculation to be  
11 rewritten at a remote place, which can save customers from having to input these data and  
12 software and prevent disadvantages caused by failure to update and the like.

13 [0028] Further, it is preferable that ~~preferably~~, the aforementioned vapor-compression  
14 refrigerating machine utilizeutilizes a direct expansion cycle. Arranging refrigerating  
15 machines of direct expansion cycle in a distributed manner for respective load systems,  
16 which can facilitate follow-up to load and individual operation/stop, which in turn can  
17 achieve improved convenience and energy efficiency.

18 Effect of Invention

19 [0029] These and other objects, features, aspects and advantages~~The fuel cell power~~  
20 ~~generation refrigerating system of the present~~~~this invention will become more apparent~~  
21 ~~from~~~~achieves~~ specific effects of making effective use of generated power of the following  
22 detailed description~~fuel cell throughout the year and to allow combined use of the present~~  
23 ~~invention when taken in conjunction with power board for the accompanying~~  
24 ~~drawings~~~~generating set and power board for air conditioning, so that an economically-~~  
25 ~~improved energy efficient fuel cell power generation refrigerating system can be~~

1 constructed with reduced footprint and equipment/construction costs.

2 **BRIEF DESCRIPTION OF THE DRAWINGS**~~Brief Description of Drawings~~

3 [0030] [Fig. 1] is a block diagram showing a power system including one embodiment of  
4 a fuel cell power generation refrigerating system of the present invention.

5 [Fig. 2] are diagrams explaining power output to a commercial system side and  
6 power output to a vapor-compression refrigerating machine.

7 [Fig. 3] is a block diagram showing another configuration of the fuel cell power  
8 generation refrigerating system.

9 [Fig. 4] is a block diagram showing still another configuration of the fuel cell  
10 power generation refrigerating system.

11 [Fig. 5] are diagrams explaining controlling the number of compression machines  
12 according to required operating load of the vapor-compression refrigerating machine and  
13 supplying generated power of the fuel cell from an inverter in a not-operating compression  
14 machine system to the commercial system side.

15 [Fig. 6] is a block diagram showing still another configuration of the fuel cell  
16 power generation refrigerating system.

17 [Fig. 7] is a block diagram showing still another configuration of the fuel cell  
18 power generation refrigerating system.

19 [Fig. 8] are diagrams explaining that power can also be supplied to the commercial  
20 system at the time when the vapor-compression refrigerating machine is operating at the  
21 maximum capacity.

22 [Fig. 9] is a block diagram showing still another configuration of the fuel cell  
23 power generation refrigerating system.

24 [Fig. 10] is a flow chart explaining the operation of the fuel cell power generation  
25 refrigerating system shown in Fig. 9.

1 [Fig. 11] is a diagram explaining that a fuel cell generation output control target  
2 value WS can be set according to a current value IC.

3 [Fig. 12] is a block diagram showing still another configuration of the fuel cell  
4 power generation refrigerating system.

5 [Fig. 13] is a diagram showing that imbalance between consumption power of load  
6 and amount of power generation of the fuel cell can be counteracted.

7 [Fig. 14] is a diagram showing that operating capacity of equipment driven by the  
8 vapor-compression refrigerating machine is increased forcedly until the fuel cell follows  
9 the load in response to reduction in detected amount of power supply to a certain degree  
10 that may cause reverse power flow.

11 [Fig. 15] is a block diagram schematically showing a power system including one  
12 embodiment of the fuel cell power generation refrigerating system of the present  
13 invention.

14 [Fig. 16] is a flow chart explaining processing of a master unit.

15 [Fig. 17] is a flow chart explaining processing of a slave unit.

16 [Fig. 18] is a block diagram schematically showing a power system including one  
17 embodiment of the fuel cell power generation refrigerating system of the present  
18 invention.

19 [Fig. 19] is a diagram showing an example of operating capacity instruction by  
20 time scheduled operation.

21 [Fig. 20] is a block diagram schematically showing a power system including one  
22 embodiment of the fuel cell power generation refrigerating system of the present  
23 invention.

24 [Fig. 21] is a flow chart explaining an example of control of the amount of power  
25 generation by a concentrated controller.

1 [Fig. 22] is a flow chart explaining an example of control of the amount of power  
2 generation of the fuel cell power generation refrigerating system.

3 [Fig. 23] is a schematic block diagram showing still another configuration of the  
4 fuel cell power generation refrigerating system of the present invention.

5 [Fig. 24] is a schematic block diagram showing still another configuration of the  
6 fuel cell power generation refrigerating system of the present invention.

7 DESCRIPTION OF THE PREFERRED EMBODIMENTSDescription of Signs

8 [0031] 1 ~~commercial system~~

9 ————— 5 ~~fuel cell power generation refrigerating system~~

10 ————— 51 ~~fuel cell body~~

11 ————— 52 ~~inverter~~

12 ————— 53 ~~vapor compression refrigerating machine~~

13 ————— 80 ~~concentrated controller~~

14 ————— 501 ~~fuel processor~~

15 ————— 502 ~~fuel cell body~~

16 ————— 503 ~~compression machine, etc.~~

17 ————— 504 ~~motor~~

18 ————— 505 ~~AC/DC converter~~

19 ————— 505' ~~bidirectional AC/DC inverter~~

20 ————— 510 ~~battery part~~

21 Best Mode for Carrying Out the Invention

22 [0032] Hereinafter, embodiments of a fuel cell power generation refrigerating system of  
23 the present invention will be described in detail with reference to accompanied drawings.

24 [0033] Fig. 1 is a block diagram showing a power system including one embodiment of a  
25 fuel cell power generation refrigerating system of the present invention.

1 [0034] This power system connects a general power load 3 to a commercial system 1 via a  
2 general power board 2, and a fuel cell power generation refrigerating system 5 via a  
3 refrigeration air-conditioning power board 4.

4 [0035] Since the aforementioned general power board 2 and refrigeration air-conditioning  
5 power board 4 are conventionally known, explanation is omitted.

6 [0036] The aforementioned general power load 3 is a load other than a refrigerating  
7 machine and air conditioner among power loads installed in a building, store, or the like,  
8 which can be exemplified by an elevator, electric light, personal computer and the like.

9 [0037] The aforementioned fuel cell power generation refrigerating system 5 includes a  
10 cell body 51 receiving conventionally-known fuel supply to generate power, an inverter 52  
11 receiving output power of the cell body 51 to convert it into ac power and a vapor-  
12 compression refrigerating machine 53 receiving ac power output from the inverter 52 as  
13 operating power. This vapor-compression refrigerating machine 53 has a motor driven by  
14 output power of the inverter 52 or commercial system power, as its driving source, and  
15 this vapor-compression refrigerating machine 53 serves as a refrigerant driving source for  
16 an air conditioner, for example. Besides, an intermediate part 54 of a connection line  
17 connecting the aforementioned inverter 52 and vapor-compression refrigerating machine  
18 53 is connected to the refrigeration air-conditioning power board 4.

19 [0038] Fig. 2 show diagrams explaining power output to the commercial system side (cf.  
20 (A) in Fig. 2) and power output to the vapor-compression refrigerating machine 53 (cf. (B)  
21 in Fig. 2).

22 [0039] As understood from Fig. 2, as required power of the vapor-compression  
23 refrigerating machine 53 decreases, power output to the vapor-compression refrigerating  
24 machine 53 decreases while power output to the commercial system 1 side increases.

25 [0040] Accordingly, it is possible to make effective use of generated power of the fuel cell

1 throughout the year and to allow combined use of the power board for the generating set  
2 and power board for air conditioning, so that an economically-improved energy-efficient  
3 fuel cell power generation refrigerating system can be constructed with reduced footprint  
4 and equipment/construction costs.

5 [0041] Fig. 3 is a block diagram showing another configuration of the fuel cell power  
6 generation refrigerating system 5.

7 [0042] This fuel cell power generation refrigerating system 5 has a fuel processor 501  
8 processing fuel supplied from the outside, a fuel cell body 502 receiving processed fuel, a  
9 compression machine 503, etc., a motor 504 serving as a driving source of the  
10 compression machine, etc., an AC/DC converter 505 connected to the commercial system  
11 1 via the refrigeration air-conditioning power board 4, an inverter 506 receiving output of  
12 the fuel cell body 502 and output of the AC/DC converter 505, a first switch 507  
13 supplying output of the inverter 506 to the motor 504, and a second switch 508 supplying  
14 output of the inverter 506 to the refrigeration air-conditioning power board 4.

15 [0043] In this case, the same inverter is used in common for power conversion between  
16 the commercial system and the compression-machine-driving motor and power conversion  
17 between the fuel cell and the compression-machine-driving motor, which thus achieves  
18 reduced footprint and equipment/construction costs as well as reduced conversion losses  
19 of the inverter, so that economy and energy efficiency can further be improved.

20 [0044] Fig. 4 is a block diagram showing still another configuration of the fuel cell power  
21 generation refrigerating system 5.

22 [0045] This fuel cell power generation refrigerating system 5 only differs from the fuel  
23 cell power generation refrigerating system 5 shown in Fig. 3 in that the compression  
24 machine 503, etc., motor 504, AC/DC converter 505, inverter 506, first switch 507, and  
25 second switch 508 are provided in two systems in parallel.

1 [0046] This case allows control of the number of compression machines according to  
2 required operating load of the vapor-compression refrigerating machine and supply  
3 generated power of the fuel cell from the inverter in a not-operating compression machine  
4 system to the commercial system side (cf. (A), (B) in Fig. 5). Further, generated power of  
5 the fuel cell can also be supplied to the commercial system side at the time of partial load  
6 operation.

7 [0047] Fig. 6 is a block diagram showing still another configuration of the fuel cell power  
8 generation refrigerating system 5.

9 [0048] This fuel cell power generation refrigerating system 5 only differs from the fuel  
10 cell power generation refrigerating system 5 shown in Fig. 3 in that: a bidirectional  
11 AC/DC inverter 505' is adopted in place of the AC/DC converter 505; the first switch 507  
12 is omitted; and a power path including the second switch 508 is omitted.

13 [0049] In this case, power supply to the refrigerating machine side and power supply to  
14 the commercial system side can be separated with a simple configuration, so that surplus  
15 generated power of the fuel cell can be supplied to the commercial system side without  
16 being affected by operating frequencies of the refrigerating machine.

17 [0050] Fig. 7 is a block diagram showing still another configuration of the fuel cell power  
18 generation refrigerating system 5.

19 [0051] This fuel cell power generation refrigerating system 5 only differs from the fuel  
20 cell power generation refrigerating system 5 shown in Fig. 6 by further including: the  
21 motor 504 connected to the refrigeration air-conditioning power board 4 bypassing the  
22 bidirectional AC/DC inverter 505'; and the compression machine 503, etc. using this  
23 motor 504 as its driving source.

24 [0052] This case achieves reduced capacity of the inverter as well as reduced costs and  
25 apparatus volume.

1 [0053] Further, setting the capacity of the fuel cell higher than the capacity of the inverter  
2 which supplies operating power to the compression-machine-driving motor of the vapor-  
3 compression refrigerating machine allows generated power to be supplied to the  
4 commercial system side via the bidirectional AC/DC inverter 505' in response to that the  
5 fuel cell is operating at the maximum capacity, so that power can also be supplied to the  
6 commercial system 1 side at the time when the vapor-compression refrigerating machine  
7 is operating at the maximum capacity (cf. (A), (B) in Fig. 8).

8 [0054] Fig. 9 is a block diagram showing still another configuration of the fuel cell power  
9 generation refrigerating system 5.

10 [0055] This fuel cell power generation refrigerating system 5 only differs from the fuel  
11 cell power generation refrigerating system 5 shown in Fig. 7 in that: a power amount  
12 detection part 6 is connected among the general power board 2, refrigeration air-  
13 conditioning power board 4 and commercial system 1; a generation output detection part 7  
14 is connected between the refrigeration air-conditioning power board 4 and bidirectional  
15 AC/DC inverter 505'; and a controller 8 receiving output of the power amount detection  
16 part 6 and output of the generation output detection part 7 to output control signals to the  
17 fuel processor 501, inverter 506 and bidirectional AC/DC inverter 505' is provided.

18 [0056] The aforementioned power amount detection part 6 may be one that actually  
19 detects the amount of power, but may be one that detects a current value as a value  
20 corresponding to the amount of power.

21 [0057] Fig. 10 is a flow chart explaining the operation of the fuel cell power generation  
22 refrigerating system 5 shown in Fig. 9. In step SP1, a current value IC flowing from the  
23 commercial system 1 side is detected, and in step SP2, it is judged whether or not the  
24 current value IC is smaller than a first threshold value ICL. In the case where the current  
25 value IC is not smaller than the first threshold value ICL, it is judged in step SP3 whether

1 or not the current value IC is smaller than a second threshold value ICH.

2 [0058] Then, in the case where the current value IC is smaller than the first threshold  
3 value ICL, a generation output control target value WS of the fuel cell power generation  
4 refrigerating system is set at 0 in step SP4.

5 [0059] In the case where the current value IC is a value between the first threshold value  
6 ICL and second threshold value ICH, the generation output control target value WS of the  
7 fuel cell power generation refrigerating system is set at  $WR \times (IC - ICL) / (ICH - ICL)$  in  
8 step SP5. WR is a fuel cell rated output.

9 [0060] In the case where the current value IC is not smaller than the second threshold  
10 value ICH, the generation output control target value WS of the fuel cell power generation  
11 refrigerating system is set at WR in step SP6.

12 [0061] In the case where the processing in step SP4, the processing in step SP5 or the  
13 processing in step SP6 is performed, fuel cell capacity control (e.g., AC output control of  
14 the bidirectional AC/DC converter 505' and fuel/air supply control at the fuel processor  
15 501) is performed in step SP7 such that generated power W becomes equal to the  
16 generation output control target value WS of the fuel cell power generation refrigerating  
17 system. However, the output of the inverter 506 is controlled by air conditioning request,  
18 for example, as conventionally known.

19 [0062] After the processing in step SP7 is performed, the processing in step SP1 is  
20 performed again. The threshold values for use in control are determined as follows:

21 for instance, the threshold value ICL is a current value corresponding to 30% of the  
22 fuel cell rated output; and

23 the threshold value ICH is a current value corresponding to the fuel cell rated  
24 output.

25 [0063] With such settings, the generation output control target value WS of the fuel cell

- 1 power generation refrigerating system can be set according to the current value IC as  
2 shown in Fig. 11.
- 3 [0064] This case allows appropriate capacity control of the fuel cell, which can prevent  
4 reverse power flow to system power and the like.
- 5 [0065] Fig. 12 is a block diagram showing still another configuration of the fuel cell  
6 power generation refrigerating system 5.
- 7 [0066] This fuel cell power generation refrigerating system 5 only differs from the fuel  
8 cell power generation refrigerating system 5 shown in Fig. 97 in that a battery part 510 is  
9 connected to the fuel cell body 502 via a charging/discharging relay 509 controlled by the  
10 controller 8.
- 11 [0067] As the aforementioned battery part 510, a secondary battery, a capacitor and the  
12 like can be illustrated by way of example.
- 13 [0068] In this case, where the general load makes fast load fluctuations so that the  
14 operating capacity of the fuel cell does not follow, the battery part 510 is charged and  
15 discharged, which allows the imbalance between consumption power of the load and the  
16 amount of power generation of the fuel cell to be counteracted (cf. Fig. 13).
- 17 [0069] Further, it may be configured such that reduction in detected amount of power  
18 supply to a degree that may cause reverse power flow is detected, and in response to this  
19 detection, the operating capacity of equipment using the vapor-compression refrigerating  
20 machine as its driving source is increased forcedly until the fuel cell follows the load (cf.  
21 Fig. 14), which can prevent the delay in following the load without providing the battery  
22 part 510, and in the case where the battery part 510 is provided, the capacity of the batter  
23 part 510 can be reduced.
- 24 [0070] Fig. 15 is a block diagram schematically showing a power system including one  
25 embodiment of the fuel cell power generation refrigerating system of the present

1 invention.

2 [0071] This power system has the fuel cell power generation refrigerating system 5  
3 connected to the commercial system 1 via the power amount detection part 6 and further  
4 via each of a plurality of refrigeration air-conditioning power boards 4. Fig. 15 only  
5 shows controllers 8, outdoor units 511 and indoor units 512 of the air conditioner, air  
6 conditioner's remote controllers 513, 514, and fuel-cell-control-dedicated communication  
7 lines 515 connecting the controllers 8, however, other components described in the above  
8 embodiments are included, as a matter of course.

9 [0072] Further, one of the aforementioned controllers 8 is a master unit, and the remainder  
10 are slave units.

11 [0073] Fig. 16 is a flow chart explaining processing of the master unit.

12 [0074] In step SP1, a current value IC flowing from the commercial system 1 side is  
13 detected, and in step SP2, it is judged whether or not the current value IC is smaller than  
14 the first threshold value ICL. In the case where the current value IC is not smaller than the  
15 first threshold value ICL, it is judged in step SP3 whether or not the current value IC is  
16 smaller than the second threshold value ICH.

17 [0075] Then, in the case where the current value IC is smaller than the first threshold  
18 value ICL, the fuel cell generation output control target value WS is set at 0 in step SP4.

19 [0076] In the case where the current value IC is a value between the first threshold value  
20 ICL and second threshold value ICH, the fuel cell generation output control target value  
21 WS is set at  $WR \times (IC - ICL) / (ICH - ICL)$  in step SP5. WR is a fuel cell rated output.

22 [0077] In the case where the current value IC is not smaller than the second threshold  
23 value ICH, the fuel cell generation output control target value WS is set at WR in step  
24 SP6.

25 [0078] In the case where the processing in step SP4, the processing in step SP5 or the

1 processing in step SP6 is performed, a target generation output WSi is calculated in step  
2 SP7 such that  $\Sigma WSi$  becomes WS (for example, the target generation output WSi is  
3 calculated by an operation of  $WSi = WS/n$ ), and in step SP8, the target generation output  
4 WSi is sent to each slave unit, and in step SP9, the capacity of the fuel cell is controlled  
5 such that the generation output becomes a target generation output WS1.

6 [0079] Note that n indicates the number of controllers 8.

7 [0080] After the processing in step SP9 is performed, the processing in step SP1 is  
8 performed again.

9 [0081] Fig. 17 is a flow chart explaining processing of a slave unit.

10 [0082] In step SP1, the target generation output WSi is received from the master unit, and  
11 in step SP2, the capacity of the fuel cell is controlled such that the generation output  
12 becomes the target generation output WSi.

13 [0083] After the processing in step SP2 is performed, the processing in step SP1 is  
14 performed again.

15 [0084] Control of the air conditioner side is intended to be carried out based on the  
16 operation settings from the air conditioner's remote controllers independently of the fuel  
17 cell. Needless to say, a refrigerating machine for another purpose can be adopted instead  
18 of the air conditioner.

19 [0085] This case allows close follow-up to air conditioning load (refrigeration load) as  
20 well as improved load follow-up by controlling the number of units even when the general  
21 load is small, and further, increased reliability in power supply.

22 [0086] Fig. 18 is a block diagram schematically showing a power system including one  
23 embodiment of the fuel cell power generation refrigerating system of the present  
24 invention.

25 [0087] In Fig. 18, a concentrated controller 80 is provided, so that an operating capacity

1 instruction is supplied from this concentrated controller 80 to each controller 8. That is, a  
2 distinction between a master unit and slave units is precluded.

3 [0088] This case allows a scheduled operation (e.g., see Fig. 19), total generation capacity  
4 control and the like to be carried out efficiently.

5 [0089] Fig. 20 is a block diagram schematically showing a power system including one  
6 embodiment of the fuel cell power generation refrigerating system of the present  
7 invention.

8 [0090] In Fig. 20, this power system has fuel cell power generation refrigerating systems 5  
9 connected to the commercial system 1 via the refrigeration air-conditioning power board  
10 4. The general power load 3 is connected to the commercial system 1 via the general  
11 power board 2. The concentrated controller 80 receiving output of the power amount  
12 detection part 6 to perform predetermined processing to supply an operation instruction to  
13 the fuel cell power generation refrigerating systems 5 is provided. Then, this concentrated  
14 controller 80 is connected to a remote monitoring computer 82 via a communication  
15 network 81 such as the Internet.

16 [0091] In this case, concentration of information to the concentrated controller 80 can  
17 achieve appropriate operation control. In addition, it is preferable that the aforementioned  
18 concentrated controller 80 further include a fee output part for at least outputting an  
19 electricity fee and a fuel fee and a control part for controlling operation of the fuel cell and  
20 performing distribution control of output power, which can perform fine priority-giving  
21 output control (control as to which output is given priority) according to season, time, and  
22 the like, so that running merits can be maximized.

23 [0092] The aforementioned fee output part may be one that calculates and outputs fees, or  
24 may be one that stores fees and outputs necessary ones.

25 [0093] In the aforementioned fee output part, however, it is preferable that unit cost data

1 and fee calculation software for fee calculation be rewritable by the remote monitoring  
2 computer 82, which can save customers from having to input these data and software and  
3 prevent disadvantages caused by failure to update and the like.

4 [0094] Fig. 21 is a flow chart explaining an example of generation amount control at the  
5 concentrated controller 80.

6 [0095] In step SP1, a target generation output WSo is calculated based on energy fee unit  
7 cost. In step SP2, the current value IC flowing from the commercial system 1 side is  
8 detected. In step SP3, it is judged whether or not the current value IC is smaller than the  
9 first threshold value ICL, and in the case where the current value IC is not smaller than the  
10 first threshold value ICL, it is judged in step SP4 whether or not the current value IC is  
11 smaller than the second threshold value ICH.

12 [0096] Then, in the case where the current value IC is smaller than the first threshold  
13 value ICL, the fuel cell generation output control target value WS is set at 0 in step SP5.

14 [0097] In the case where the current value IC is a value between the first threshold value  
15 ICL and second threshold value ICH, the fuel cell generation output control target value  
16 WS is set at  $WSo \times (IC - ICL)/(ICH - ICL)$  in step SP6. ~~WR is a fuel cell rated output.~~

17 [0098] In the case where the current value IC is not smaller than the second threshold  
18 value ICH, the fuel cell generation output control target value WS is set at WSo in step  
19 SP7.

20 [0099] In the case where the processing in step SP5, the processing in step SP6 or the  
21 processing in step SP7 is performed, the target generation output WSi is calculated in step  
22 SP8 such that  $\sum WSi$  becomes WS (for example, the target generation output WSi is  
23 calculated by an operation of  $WSi = WS/n$ ), and in step SP9, the target generation output  
24 WSi is sent to each fuel cell power generation refrigerating system 5.

25 [0100] After the processing in step SP9 is performed, the processing in step SP1 is

1 performed again.

2 [0101] The processing in the aforementioned step SP1 is performed, for example, as  
3 follows:

4 [0102] First, calculation of electricity fee CE [yen/kWh] is carried out as follows:

5 summer time (7/1~9/30) on weekdays, 13:00~16:00, CE=15.9;

6 summer time (7/1~9/30) on weekdays, 8:00~13:00, 16:00~22:00, CE=14.7;

7 others (10/1~6/30) on weekdays, 8:00~22:00, CE=13.65; and

8 22:00~8:00 or holidays, CE=6.05.

9 Further, calculation of gas fee CG [yen/kWh] is carried out as follows:

10 CG=4.

11 Further, calculation of maintenance costs CM [yen/kWh] is carried out as follows:

12 CM=2.

13 Further, calculation of generation efficiency E [-] is carried out as follows:

14 E=0.45.

15 Based on these, calculation of the target generation output WSo [kW] is carried out  
16 as follows:

17 WSo=WR in the case where  $CG/E+CM < CE$  holds; and

18 WSo=0 in the case where  $CG/E+CM \geq CE$  holds.

19 Fig. 22 is a flow chart explaining processing of each fuel cell power generation  
20 refrigerating system 5.

21 [0103] In step SP1, the target generation output WSi is received from the concentrated  
22 controller 80, and in step SP2, the capacity of the fuel cell is controlled such that the  
23 generation output becomes the target generation output WSi.

24 [0104] After the processing in step SP2 is performed, the processing in step SP1 is  
25 performed again.

1 [0105] Control of the air conditioner side is intended to be carried out based on the  
2 operation settings from the air conditioner's remote controllers independently of the fuel  
3 cell. Needless to say, a refrigerating machine for another purpose can be adopted instead  
4 of the air conditioner.

5 [0106] In each of the above-described embodiments, it is preferable that the  
6 aforementioned vapor-compression refrigerating machine be one that utilizes a direct  
7 expansion cycle. Arranging refrigerating machines of direct expansion cycle in a  
8 distributed manner for respective load systems can facilitate follow-up to the load and  
9 individual operation/stop, which in turn can achieve improved convenience and energy  
10 efficiency.

11 [0107] Fig. 23 is still another configuration of the fuel cell power generation refrigerating  
12 system.

13 [0108] This fuel cell power generation refrigerating system 5, as conventionally known,  
14 has a refrigerant circuit for compressing refrigerant gas by the compression machine 503  
15 which uses a motor as its driving source, condensing by a condenser 520, decompressing  
16 by an expansion valve 518 and thereafter evaporating refrigerant by an evaporator 519,  
17 and further, a four-way valve 521 for reversing the flow of refrigerant is provided so as to  
18 perform a cooling operation or a heating operation.

19 [0109] Fig. 23 shows the heating operation, and the evaporator 519 is an outdoor heat  
20 exchanger, and the condenser 520 is an indoor heat exchanger. The four-way valve 521 is  
21 switched at the time of cooling operation, so that the outdoor heat exchanger becomes a  
22 condenser, and the indoor heat exchanger becomes an evaporator. In the cooling  
23 operation, the refrigerant is compressed by an expansion valve 517 provided for each  
24 room.

25 [0110] Then, an exhaust-heat-using heat exchanger 516 for heat exchanging between

- 1 exhaust heat from the fuel cell body 502 and refrigerant is provided.
- 2 [0111] In this case, exhaust heat is utilized in the same system to achieve appropriate use,
- 3 which in turn can improve energy efficiency.
- 4 [0112] Fig. 24 is still another configuration of the fuel cell power generation refrigerating
- 5 system.
- 6 [0113] This fuel cell power generation refrigerating system 5 only differs from the fuel
- 7 cell power generation refrigerating system 5 shown in Fig. 23 in that, as the exhaust-heat-
- 8 using heat exchanger 516, one that heat exchanges between exhaust heat from the fuel cell
- 9 body 502 and water to provide hot water supply is adopted.
- 10 [0114] However, it is not limited to the one that provides hot water supply, but it is
- 11 applicable to various devices that utilizes heat.
- 12 [0115] In this case, exhaust heat can be utilized preferentially in devices having a lower
- 13 energy utilization efficiency than the refrigerating machine and the like, so that energy
- 14 efficiency can be improved.
- 15 While the invention has been shown and described in detail, the foregoing
- 16 description is in all aspects illustrative and not restrictive. It is therefore understood that
- 17 numerous modifications and variations can be devised without departing from the scope of
- 18 the invention.